Chapter 12
Weather and Oceanography

Overview

Introduction

Boat crews operate in constantly changing environments. Weather and sea conditions interact causing many different types of situations. It is important to understand these conditions and how to operate in them. The information in this chapter will concentrate on the effects the environment has on the water and the problems these effects can cause. It will not provide an explanation of advanced meteorology or oceanography.

Wind, fog, rain, and cold temperatures (sea and air) can be very dangerous. Any of these can complicate the simplest mission, not only increasing the danger, but also lessening the survival probability of persons in distress.

Effects of wind, current, and tide can also dramatically affect a boat's behavior. A coxswain must understand how outside influences cause the boat to react in different ways.

In this chapter

These items are discussed in this chapter:

Section A. Weather

Overview

Introduction

One of the greatest hazards to the boatcrew occurs when its members must work close inshore or in heavy weather. The waves, seas, and surf can present the greatest challenges to seamanship and survival skills. Your operating area of responsibility will provide its own unique weather characteristics. Some major distinct conditions occur in various regions of the United States in predictable patterns. For example:

- *Bermuda High*. A semipermanent high pressure area off of Bermuda. It affects the general wind circulation and the weather of the East Coast, especially summer heat waves.
- *Santa Ana Wind*. On the southern California coast, a dry, warm wind that blows through a pass and down the Santa Ana valley. It may blow so strongly that it threatens small craft near the coast.
- *Taku Wind*. A strong east-northeast wind, in the vicinity of Juneau, Alaska, between October and March, that can threaten small craft near the coast. It sometimes reaches hurricane force at the mouth of the Taku River.

In this section

This section contains the following information:

Wind

A.1. General

High winds account for considerable destruction in the marine environment every year. Everyone knows water seeks its own level; the same is true with air. Air tends to equalize its pressure by flowing from a high-pressure area to a low-pressure area, producing wind.

A.2. Afternoon wind increases

Members of the boating public often get underway in the calm waters of the cool early morning. By afternoon, when they try to get home, the bay or ocean is so choppy that they may find themselves in need of assistance. The wind changes so drastically because the sun warms the Earth. The land warms faster than the surface of the water and radiates heat to the overlying air, warming it. This warm air rises, reducing the atmospheric pressure in that area. The air offshore over the ocean is cool, and cool air is dense and heavy.

The cool air from offshore flows inland in an attempt to equalize the pressure differential caused by the rising warm air. This flow produces wind, known as sea breeze. After sunset, the inland area cools more quickly than the water, and the wind diminishes.

NOTE

> Wind direction is the compass heading from which the wind blows.

Sea breezes typically reach their highest speeds during the period of maximum heating (i.e., during mid-afternoon). In some areas a land breeze can be established late at night or early in the morning. For this breeze to occur, the sea surface temperature must be higher than the air temperature over land, along with weak winds prior to the breeze.

A.3. Beaufort wind scale

The Beaufort Wind Scale (See Figure 12-1) numbers define a particular state of wind and wave. The scale allows mariners to estimate the wind speed based on the sea state.

NOTE

> The Beaufort Scale extends to force 18. For boat operating purposes, Figure 12-1 is limited to force 10.

BEAUFORT SCALE	WIND SPEED (KNOTS)	INDICATIONS	APPROXIMATE WAVE HEIGHT (FEET)	(METERS)	DAVIS SEA STATE
0	calm	Mirror like.	0	0	0
1	1-3	Ripples with appearance of scales.	0.25	0.1	0
2	4-6	Small wavelets that do not break. Glassy appearance.	0.5-1	0.2-0.3	1
3	7-10	Large wavelets. Some crests begin to break. Scattered whitecaps.	2-3	0.6-1	2
4	11-16	Small waves becoming longer. Fairly frequent whitecaps.	3.5-5	1-1.5	3
5	17-21	Moderate waves. Pronounced long form. Many whitecaps.	6-8	2-2.5	4
6	22-27	Large waves begin to form. White foam crests are more extensive. Some spray.	9.5-13	3-4	5
7	28-33	Sea heaps up. White foam from breaking waves begins to blow in streaks along the direction of the waves.	13.5-19	4-5.5	6
8	34-40	Moderately high waves of greater length. Edges of crests break into spindrift foam blown in well marked streaks in the direction of the waves.	18-25	5.5-7.5	6
9	41-47	High waves. Dense streaks of foam. Sea begins to roll. Spray affects visibility.	23-32	7-10	6
10	48-55	Very high waves with over-hanging crests. Foam in great patches blown in dense white streaks. Whole surface of sea takes on a white appearance. Visibility affected.	29-41	9-12.5	7

Beaufort Wind Scale
Figure 12-1

A.4. Weather warning signals

The National Weather Service provides radio weather broadcasts. Although no longer required to be displayed, various shore activities may still use a system of flag and light signals to announce weather warnings. These weather warnings and their flages and lights signals are summarized below.

STORM WARNINGS	WINDS	DAY SIGNAL ONSHORE	NIGHT SIGNAL ON SHORE
Small craft advisory (conditions dangerous to small craft operations)	Up to 33 knots	Red pennant	Red-over-white light
Gale	34-47 knots	Two red pennants	White-over-red lights
Storm	48-63 knots	Square red flag with black center	Two red lights
Hurricane	64 knots and above	Two square red flags with black centers	Three vertical lights - red, white, red

Thunderstorms and Lightning

A.5. Thunderstorms

Thunderstorms have violent vertical movement of air. They usually form when air currents rise over locally warmed areas or a cold front forces warm moist air aloft. Thunderstorms are dangerous not only because of lightning, but also because of the strong winds and the rough, confused seas that accompany them. Sharp intermittent static on the AM radio often indicates a thunderstorm.

A.6. Lightning

Lightning is a potentially life-threatening phenomenon associated with some storms. Not all storms are thunderstorms, but all thunderstorms have lightning. Lightning occurs when opposite electrical charges within a thundercloud, or between a cloud and the earth, attract. It is actually a rapid equalization of the large static charges built up by air motion within the clouds. Lightning is very unpredictable and has immense power. A lightning "bolt" usually strikes the highest object on the boat, generally the mast or radio antenna. A mast with a full grounding harness affords excellent protection.

A.6.a. Grounding systems

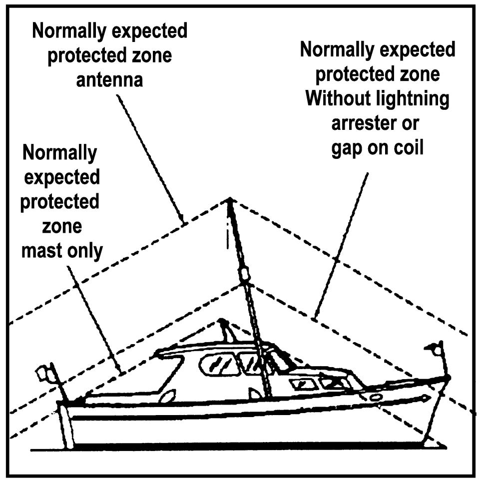
Coast Guard standard boats have a **grounding system** (most commercially available vessels do not). A boat can minimize being struck by lightning by staying in port (assuming there are higher objects about) during thunderstorms and by installing a grounding system similar to those found on buildings and other land structures. The grounding system provides lightning a path to reach ground without causing damage or injury. Figures 12-2 and 12-3 show the lightning protected zone for a motorboat and a sailboat. Figure 12-4 diagrams how a grounding system can be installed on a boat.

NOTE

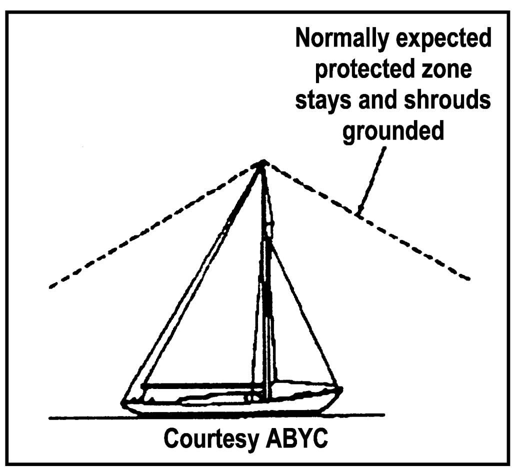
A grounding system on a boat provides lightning with a path to reach the water without causing severe damage or injury. Despite the high number of boats on the water, reports of lightning strikes on boats are rare.

WARNING ☟

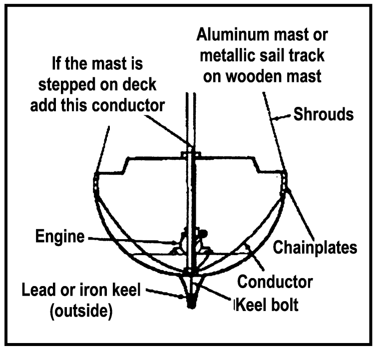
Fiberglass radio antennas are not suitable protection and antennas with loading coils offer protection only to the height of the loading coil (See figures 12-2 through 12-4). Underwriters' texts such as the National Fire Protective Association manuals describe a proper grounding system.

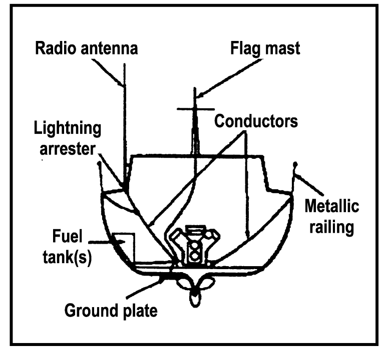


Lightning Protected Zone on a Motorboat
Figure 12-2



Lightning Protected Zone on a Sailboat
Figure 12-3





Grounding System on a Sailboat and a Motorboat
Figure 12-4

A.7. Distance from a thunderstorm

The boat's distance from a thunderstorm can be estimated by knowing it takes about five seconds for the sound of thunder to travel each mile.

- Observe the lightning flash.
- Count the number of seconds it takes for the sound of its thunder to arrive.
- Convert to miles by dividing the number of seconds by 5.

NOTE

> Counting "one thousand one, one thousand two, one thousand three, one thousand four, one thousand five" will aid you in correctly counting seconds.

A.8. Safety

If caught in a lightning strike area, head for shore or the nearest shelter. While underway, stay inside the boat, keep crew members low, and stay dry. Avoid touching metal, such as metal shift and throttle levers and metal steering wheels. Avoid contact with the radio. If lightning strikes, expect your compass to be inaccurate and onboard electronics to suffer extensive damage.

A.9. Waterspouts

NOTE

While waterspouts are found more frequently in tropical areas, they are not uncommon in higher latitudes.

A **waterspout** is a small, whirling storm over water or inland waters. There are two types of waterspouts:

- violent convective storms over land moving seaward (tornadoes), and
- storms formed over sea with fair or foul weather (more common than tornadoes).

Waterspouts develop as a funnel-shaped cloud and when fully developed extends from the water's surface to the base of a cumulus cloud. The water in a waterspout is mostly confined to its lower portion. The air in waterspouts may rotate clockwise or counter-clockwise, depending on the manner of formation. Waterspouts vary in diameter, height, strength and duration and are found most frequently in tropical regions.

Fog

A.10. General	**Fog** is a multitude of minute water droplets hanging in the atmosphere, sufficiently dense to scatter light rays and reduce visibility. Fog makes locating anything more difficult. and also makes the voyage to and from the scene more hazardous.
A.11. Advection fog	The most troublesome type of fog to mariners is **advection fog**. Advection means horizontal movement. This type of fog occurs when warm air moves over colder land or water surfaces. The greater the difference between the air temperature and the underlying surface temperature, the denser the fog. Sunlight hardly affects advection fog. It can occur during either the day or night. An increase in wind speed or change in direction may disperse advection fog; however, a slight increase in wind speed can actually make the fog layer thicker.
A.12. Radiation (ground) fog	**Radiation fog** occurs mainly at night with the cooling of the earth's surface and the air, which is then cooled below its dew point as it touches the ground. It is most common in middle and high latitudes, near the inland lakes and rivers which add water vapor to the fog. It clears slowly over water because the water warms less from night to day than does land. Sunlight burns off radiation fog.
A.13. Fog frequency	The United States' Pacific Coast fog appears most frequently in areas from the northern tip of Washington State to around Santa Barbara, California. The nation's Atlantic Coast fog is most common from the northern tip of Maine to the southern tip of New York. Fog appears, on the average, more than 10% of the time in these waters. Off the coasts of Maine and Northern California it averages more than 20%. The fog frequency near Los Angeles, California, on the other hand, is about three times that of Wilmington, North Carolina.
A.14. Operating in fog	When in fog, slow down to allow enough time to maneuver or stop (i.e., operate your boat at a safe speed). When engaged in towing extra caution should be exercised. Display the proper navigation lights and sound appropriate sound signals. Employ all available navigation aids.

NOTE

Consider anchoring to await better visibility, especially if transiting congested areas or narrow channels. Remember, fog increases the chance of a collision or grounding.

Station a lookout well forward and away from the engine sounds and lights, to listen and look for other signals. Navigation Rules requires the use of a proper lookout. Besides listening for other boats, the lookout should listen for surf in case the navigational plot is incorrect. If the facility has dual steering stations, one inside and one exposed, use the exposed one in restricted visibility conditions. Being outside allows the lookout or operator the best chance to hear dangers to the boat.

Ice

A.15. General

Temperature and salinity govern the freezing point of water; however, winds, currents, and tides can slow the formation of ice by mixing in warmer water from below the surface. Fresh water freezes at 0°C/32°F, but the freezing point of seawater decreases because of salinity, the dissolved solid material in water often referred to as salt. Typically, seawater freezes at or below -1°C/30°F.

Shallow bodies of low-salinity water freeze more rapidly than deeper basins because a lesser volume must be cooled. Once the initial cover of ice has formed on the surface, no more mixing can take place from wind/wave action, and the ice will thicken. As a result, the first ice of the season usually appears in the mouths of rivers that empty over a shallow continental shelf. During the increasingly longer and colder nights of late autumn, ice forms along the shorelines as a semi-permanent feature and widens by spreading into more exposed waters. When islands are close together, ice can cover the sea surface between the land areas.

A.16. Topside icing

One of the most serious effects of cold weather is that of topside icing, caused by wind-driven spray, particularly if the ice continues to accumulate. Ice grows considerably thicker because of splashing, spraying, and flooding. It causes an increase in weight on decks and masts (the outer structure). It also produces complications with the handling and operation of equipment, and creates slippery deck conditions. The ice accumulation causes the boat to become less stable and can lead to capsizing.

NOTE

The easiest and most effective way to minimize icing is to slow down.

NOTE

Ice can be broken away by chipping it off with mallets, clubs, scrapers, and even stiff brooms. Use special care to avoid damage to electrical wiring and finished surfaces.

Forecasting

A.17. General

Listening to either a news media broadcast meteorologist or NOAA Weather Radio, coupled with local knowledge, should make everyone safe weather-wise. However, many old common weather "hunches" are often correct, but only with some basic weather knowledge and a tool (e.g., barometer or thermometer) with which to cross-check the belief.

A.18. Weather indicators

Even experts are far from 100% correct. However, the following generalized table, Figure 12-5, can assist in forecasting weather changes.

Condition	Deteriorating Weather	Impending Precipitation	Clearing Weather	Continuing Fair Weather	Impending Strong Winds
CLOUDS					
Clouds lowering and thickening	X				
Puffy clouds beginning to develop vertically and darkening	X				
Sky is dark and threatening to the west					X
Clouds increasing in numbers, moving rapidly across sky	X				X
Clouds moving in different directions at different heights	X				X
Clouds moving from east or northeast toward the south	X				
Transparent veil-like cirrus clouds thickening; ceiling lowering		X			
Increasing south wind with clouds moving from the west		X			
Cloud bases rising			X		
Rain stopping, clouds breaking away at sunset			X		
Clouds dotting afternoon summer sky				X	
Clouds not increasing, or instead decreasing				X	
Altitude of cloud bases near mountains increasing				X	

Generalized Weather Indicators
Figure 12-5

Condition	Deteriorating Weather	Impending Precipitation	Clearing Weather	Continuing Fair Weather	Impending Strong Winds
SKY					
Western sky dark and threatening	**X**				
A red sky in morning	**X**				**X**
Red western sky at dawn		**X**			
Gray early morning sky showing signs of clearing			**X**		**X**
Red eastern sky with clear western sky at sunset				**X**	
Clear blue morning sky to west				**X**	
PRECIPITATION					
Heavy rains occurring at night	**X**				
Rain stopping, clouds breaking away at sunset			**X**		
Temperatures far above or below normal for time of year	**X**				
A cold front passing in the past four to seven hours (in which case the weather has probably already cleared)			**X**		
FOG, DEW, AND FROST					
Morning fog or dew			**X**		
Early morning fog that clears				**X**	
Heavy dew or frost				**X**	
No dew after a hot day		**X**			
WIND					
Wind shifting north to east and possibly through east to south	**X**				
Strong wind in morning	**X**				
Increasing south wind with clouds moving from the west		**X**			
Gentle wind from west or northwest				**X**	
Bright Moon and light breeze				**X**	
Winds (especially north winds) shifting to west and then to south		**X**			
BAROMETER					
Barometer falling steadily or rapidly	**X**				
Steadily falling barometer		**X**			
Barometer rising			**X**		
Barometer steady or rising slightly				**X**	

Condition	Deteriorating Weather	Impending Precipitation	Clearing Weather	Continuing Fair Weather	Impending Strong Winds
VISUAL PHENOMENA					
A ring (halo) around the moon	**X**				
Smoke from stacks lowers					**X**
Distant objects seeming to stand above the horizon		**X**			
If on land, leaves that grow according to prevailing winds turnover and show their backs					**X**
Halo around sun or moon		**X**			
Smoke from stacks rising			**X**		
Smoke from stacks lowering	**X**				
Bright Moon and light breeze				**X**	
AUDIBLE PHENOMENA					
Very clear sounds that can be heard for great distances		**X**			
Dull hearing, short range of sound				**X**	
Static on AM radio	**X**				

A.19. Local conditions

Learn how conditions in your locality tend to vary because of nearby mountains, lakes, or oceans. The National Weather Service's Table of Average Conditions, Figure 12-6, also can assist in forecasting weather conditions.

WIND DIRECTION	BAROMETRIC PRESSURE	GENERAL FORECAST
SW to NW	30.10 to 30.20 - steady	Fair, with little temperature change for 1 to 2 days.
SW to NW	30.10 to 30.20 - rising rapidly	Fair, with warmer weather and rain within 2 days.
SW to NW	30.20 or above - steady	Remaining fair with little temperature change.
SW to NW	30.20 or above - falling slowly	Fair and slowly rising temperature for about 2 days.
S to SE	30.10 to 30.20 - falling slowly	Rain with 24 hours.
S to SE	30.10 to 30.20 - falling rapidly	Rain within 12 to 24 hours. Wind will rise.
SE to NE	30.10 to 30.20 - falling slowly	Rain within 12 to 18 hours. Wind will rise.
SE to NE	30.10 to 30.20 - falling rapidly	Rain within 12 hours. Wind will rise.
SE to NE	30.00 or below - falling slowly	Rain will continue 1 or more days.
SE to NE	30.00 or below - falling rapidly	Rain with high winds in a few hours. Clearing within 36 hours - cooler in winter.
E to NE	30.10 or above - falling slowly	Summer: light winds and rain in 2 to 4 days. Winter: rain or snow within 24 hours.
E to NE	30.10 or above - falling rapidly	Summer: probable rain in 12 to 24 hours. Winter: rain and snow within 12 hours.
S to SW	30.00 or above - rising slowly	Clearing within a few a hours; then fair for several days.
S to E	29.80 or below - falling rapidly	Severe storm within a few hours; then clearing within 24 hours, colder in winter
E to N	29.80 or below - falling rapidly	Severe storm in few hours. Heavy rains or snowstorm, followed by colder air in winter.
Swinging	29.30 or below - rising rapidly	End of storm - clearing to West and colder

National Weather Service Table of Average Conditions
Figure 12-6

NOTE

Barometric pressure is in inches of mercury, corrected to sea level pressure. A rapid rise or fall in barometric pressure is defined as greater than or equal to 0.04 inches in three hours.

Section B. Oceanography

Introduction

Oceanography is a broad field encompassing the study of waves, currents, and tides. It includes the biology and chemistry of the oceans and the geological formations that affect the water. Boat crew members must have an appreciation of all these factors to safely operate in an ever-changing environment. Some major distinct conditions occur in various regions of the United States. For example:

- The freezing over of the Great Lakes.
- The *Gulf Stream*. A powerful, warm ocean current flowing along the East Coast. In the Straits of Florida, it greatly affects the speed of advance of vessels underway and drifting objects; off of Cape Hatteras, North Carolina, it "collides" with weather systems and can cause dangerous wave conditions.
- The West Coast, in general, has a narrow continental shelf (a gentle bottom slope) followed by a sharp drop into great ocean depth.

In this section

This section contains the following information:

Waves

B.1. General

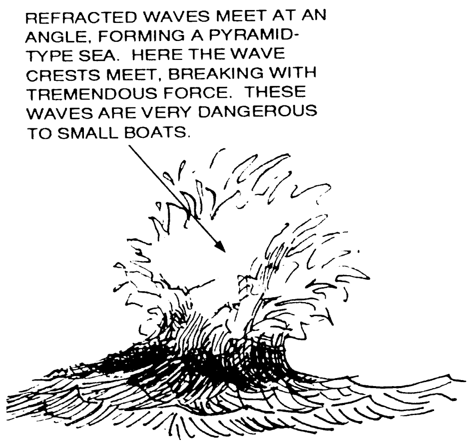
By understanding how **waves** form and behave, boat crew members know what to expect and how to minimize danger to both boat and crew.

B.2. Definitions

The following definitions will help in understanding waves:

Term	Definition
Waves	Waves are periodic disturbances of the sea surface, caused by wind (and sometimes by earthquakes).
Crest	The top of a wave, breaker, or swell.
Foam Crest	Top of the foaming water that speeds toward the beach after the wave has broken, popularly known as **white water**.
Wave Length	The distance from one wave crest to the next in the same wave group or series.
Trough	The valley between waves.
Wave Height	The height from the bottom of a wave's trough to the top of its crest; measured in the vertical, not diagonal.
Fetch	The unobstructed distance over which the wind blows across the surface of the water.
Series	A group of waves that seem to travel together, at the same speed.
Period	The time, in seconds, it takes for two successive crests to pass a fixed point.
Frequency	The number of crests passing a fixed point in a given time.

Term	Definition
Wave Refraction	Refraction means bending. Wave refraction occurs when the wave moves into shoaling water, interacts with the bottom and slows. The first part of the wave slows, causing the crest of the wave to bend toward the shallower water. As a result the waves tend to become parallel to the underwater contours. The key to the amount of refraction that occurs is the bottom terrain. This can also occur when a wave passes around a point of land, jetty, or an island. While different segments of the wave travel in different depths of water, the crests bend and the waves change direction constantly. This is why wave fronts become parallel to the underwater contours and the shoreline, and why an observer on the beach sees larger waves coming in directly toward the beach while offshore they approach at an angle. Waves refracted off shoals can produce very dangerous seas. As the waves pass on each side of the shoal, they refract from their original line of travel toward each other. The angle from where they meet behind the shoal produces a pyramid-type sea where the wave crests meet (see Figure 12-7).

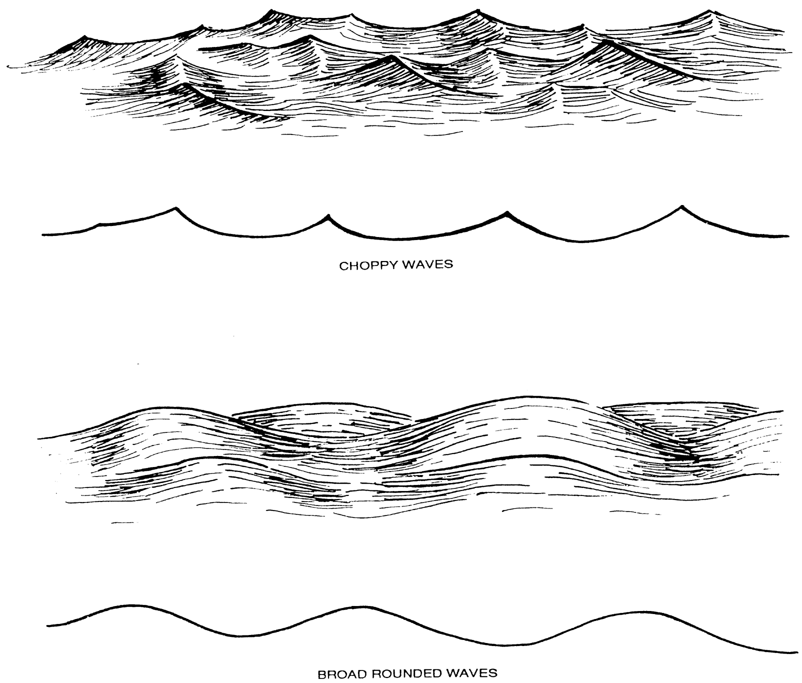


Wave Refraction
Figure 12-7

Term	Definition
Wave Reflection	Any obstacle can reflect part of a wave. This includes under water barriers (e.g., submerged reefs or bars), although the main waves may seem to pass over them without change. These reflected waves move back towards the incoming waves. When the obstacles are vertical or nearly so, the waves may be reflected in their entirety.
Interference	Waves refracted or reflected can interact with other waves. This action may increase or decrease wave height, often resulting in unnaturally high waves. Interference may even result in standing-wave patterns (waves that consistently appear to peak in the same spot). Interference can be of particular concern because it may result in a boat being subjected to waves from unexpected directions and of unexpected size.
Swell	Swells are the waves that have moved out of the area in which they were created. The crests have become lower, more rounded, and symmetrical. They can travel for thousands of miles across deep water without much loss of energy. Generally, a swell's direction of travel differs from the wind direction by at least 30^{o}.
Breaker	A breaking wave.
Surf	Several breakers in a continuous line.
Surf Zone	The area near shore in which breaking occurs continuously in various intensities.
Breaker Line	The outer limit of the surf. All breakers may not present themselves in a line. Breakers can occur outside the breaker line and seem to come from nowhere.
Comber	A wave on the point of breaking. A comber has a thin line of white water upon its crest, called **feathering**.

B.3. Wave types

The wind generates waves by moving over the water's surface. As wind speed increases white caps appear. As the wind continues, the waves become higher and longer. The Beaufort wind scale (See Figure 12-1) shows the size of waves in open water for a given wind strength. There are two major types of waves: the broad, rounded waves associated with deep water, and the more choppy waves found in shallow water (e.g., in bays and inland lakes) (see Figure 12-8).



The Two Major Types of Waves
Figure 12-8

B.4. Breaking waves

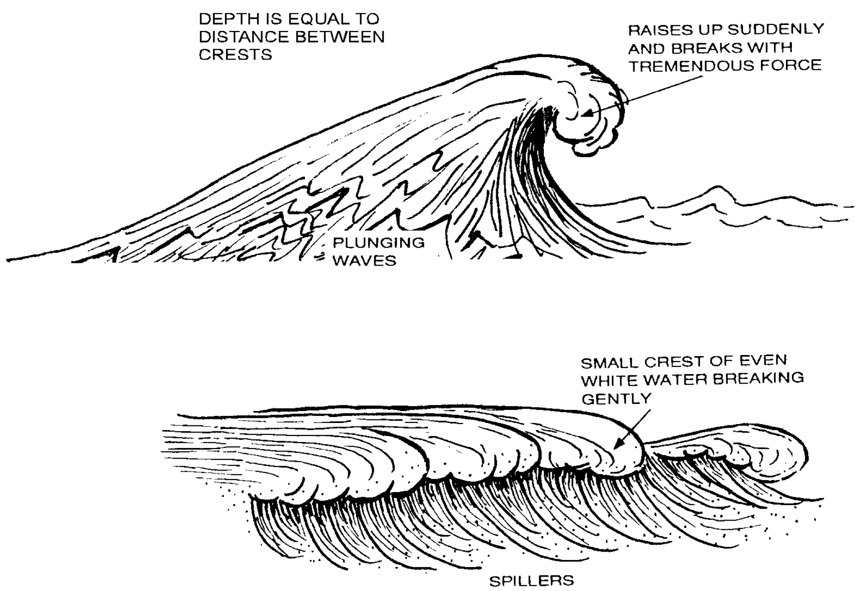
Breaking waves are the most dangerous kind of wave for boat operations. How dangerous the wave is depends on the ratio of wave height to length, and on wave frequency. Steep sloped waves are the most dangerous. There are three main types of breaking waves: **plunging, spilling, and surging breakers**.

WARNING ☜

> A 6-meter/20-foot breaker will drop 1,362,000 kilograms/1500 tons of water on a boat and can swamp and/or severely damage it.

B.4.a. Plunging waves

Plunging waves result when there is a sudden lack of water ahead of the wave, such as in a steep rise of the ocean floor. This situation prevents the wave from traveling along, and causes the crest to be hurled ahead of the front of the wave and break with tremendous force (see Figure 12-9).



Plunging and Spilling Waves
Figure 12-9

B.4.b. Spilling breakers

Spilling breakers result from waves of low steepness moving over a gentle sloping ocean floor. They normally have a small crest of white water spreading evenly down the wave, and break slowly without violence (see Figure 12-9).

B.4.c. Surging breakers

A surging break occurs on very steep beaches. The wave builds very quickly and expends its energy on the beach. It is very unlikely that you will encounter a surging break while aboard a boat unless you are beaching it on a very steep beach.

B.5. Deep water waves

A **deep water wave** is a wind wave where the depth of the water is greater than one-half the wave length.

B.6. Shallow water waves

A **shallow water wave** travels in water where the depth is less than one-half the wave length. If the depth of water is small in comparison to the wave length, the bottom will change the character of the wave.

NOTE ✍

> As the waves travel out from their origin, they become swells developing into a series of waves equidistant apart which track more or less at a constant speed. Consequently, it is possible to time series of breakers.

B.7. Wave series

NOTE ✍

> Tidal currents going against the waves will make the waves steeper.

Wave series are irregular because of constant shifting of wind direction and speed. Storms at sea create masses of waves that build up in groups higher than other waves. Breakers vary in size and that there is no regular pattern or sequence to their height. But while the space or interval between series of breakers may vary, it is fairly regular. Despite the interval, breakers tend to stay the same for hours at a time.

The **height and period** of a wave depends on:

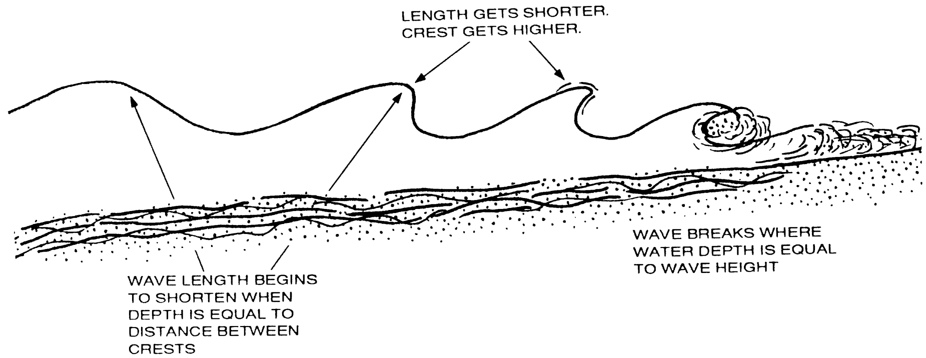
- The speed of the wind.
- The amount of time the wind has been blowing.
- The unobstructed distance over which the wind travels, known as fetch. Nearness to land will limit fetch, if the wind is blowing offshore.

The **lifecycle** of a wave consists of its:

- Generation by a wind.
- Gradual growth to maximum size.
- Distance traveled across the sea.
- Dissipation as wind decreases or when the wave impacts against the shore or an object.

B.8. Surf

Irregular waves of deep water become organized by the effects of the contact with the bottom. They move in the same direction at similar speeds. As the depth of water decreases to very shallow, the waves break and the crests tumble forward. They fall into the trough ahead usually as a mass of foaming white water. This forward momentum carries the broken water forward until the wave's last remaining energy becomes a wash rushing up the beach. The zone where the wave gives up this energy and the systematic water motions, is the **surf** (see Figure 12-10).



Surf
Figure 12-10

NOTE

Operators can size up the surf situation by comparing the swell height and length with the water depth.

Sometimes there are two breaks of surf between the beach and the outer surf line. These breaks result from an outer sand bar or reef working against the wave causing the seas to pile up. The movement of water over such outer bars forms the inner surf belt as the water rolls toward the shore. The surf that forms around an inlet depends on the size of approaching swells and the bottom contours. The waves' speed and shape change as they approach shallow coastal waters. They become closer together (as their speed slows) and steeper as they contact the bottom. This change typically happens at a point where the water is approximately one half as deep as the wave's length.

The momentum caused by the breaking top of a wave will cause the water to fall ahead or curl because the water mass is not actually going forward. Momentum is what gives the curl of breakers its tremendous force.

WARNING

Stay out of the wave's curl.
Coast Guard utility boat operations are not permitted in breaking surf or bar conditions. Auxiliarists are not authorized to operate in surf.

Currents

B.9. General

NOTE

Current direction is the compass heading toward which the water moves.

Tide is the vertical rise and fall of the ocean water level caused by the gravitational attraction of the sun and moon. A **tidal current** is the horizontal motion of water resulting from the change in the tide. It is different from ocean currents, river currents, or those created by the wind. Tidal currents are of particular concern in boat operations.

B.10. Flood, ebb, and slack currents

Flood current is the horizontal motion of water toward the land, caused by a rising tide. **Ebb current** is the horizontal motion away from the land, caused by a falling tide. **Slack water** is the period that occurs while the current is changing direction and has no horizontal motion.

An outgoing or ebb current running across a bar builds up a more intense sea than the incoming or flood current. The intense sea results because the rush of water out against the incoming ground swell slows the wave speed and steepens the wave prematurely.

B.11. Longshore currents

Longshore currents run parallel to the shore and inside the breakers. They are the result of the water transported to the beach by the waves.

CAUTION !

Pay close attention to longshore currents - they can cause a boat to broach or the object of a search to move further than expected.

B.12. Eddy currents

Eddy currents (eddies) occur at channel bends, near points of land, and at places where the bottom is uneven.

CAUTION !

Watch for and avoid eddies - they can abruptly change speed and steering control of boats.

B.13. Wind effects on current

Wind affects the speed of currents. Sustained wind in the same direction as the current, increases the speed of the current by a small amount. Wind in the opposite direction slows it down and may create a chop. A very strong wind, blowing directly into the mouth of an inlet or bay, can produce an unusually high tide by piling up the water. Similarly, a very strong wind blowing out of a bay can cause an unusually low tide and change the time of the high or low tide.

B.14. Effects on boat speed

When going with the current, a boat's speed over ground is faster than the speed/rpm indication. When going against the current, a boat's speed over ground is slower than the speed/rpm indication.

B.15. Effects on boat maneuverability

When working in current, the boat's maneuverability depends on its speed through the water. Although a boat has significant speed in relation to fixed objects (e.g., a pier) when going with the current, a boat lacks maneuverability unless there is sufficient water flow past the rudder. When going into the current, maneuverability is usually improved as long as enough headway is maintained. However, at slow speeds, even a small change in course can have the bow swing greatly as the water flow pushes on one side of the bow.

B.16. Crossing the current

When crossing the current to compensate for the set, a boat may be put into a **crab**, i.e., the boat may be forced off course by the current or wind. Because of this maneuver, the boat heading and the actual course made good will be different. When the boat is crabbing, the heading will not be the intended course of the boat. Therefore, navigate the current or wind by sighting on a fixed object (such as a range) or by marking the bearing drift on an object in line with the destination. Piloting in currents is covered in more detail in the *Navigation* chapter.

B.17. Tide and tidal current changes

The change of direction of the tidal current always lags behind the turning of the tide. This difference occurs by a time period that varies according to the physical characteristics of the land around the body of water, as well as the bottom topography. For instance, with a straight coast and only shallow indentations, there is little difference between the time of high or low tide and the time of slack water. However, where a large body of water connects with the ocean through a narrow channel, the tide and the current may be out of phase by as much as several hours. In a situation such as this, the current in the channel may be running at its greatest velocity when it is high or low water outside.

B.18. Tidal Current Tables	It is important for each operator operating in tidal waters to know the set (direction toward) and drift (speed expressed in knots) of the tidal currents in the area. Obtain this information from the *Tidal Current Tables*. The National Ocean Survey (NOS) annually publishes the *Tidal Current Tables*. It contains a table for reference stations and a table for subordinate stations.
B.18.a. Table 1	Table 1 lists the daily times of slack water and the times and velocities of maximum flood and ebb at the reference stations (See Figure 12-11).
B.18.b. Table 2	Table 2 includes the latitude and longitude of each subordinate station (and reference stations). It also includes the time and differences for slack water and maximum current, the speed ratios for maximum flood and ebb, and the direction and average speed for maximum flood and ebb currents (see Figure 12-12).

Bay of Fundy Entrance (Grand Manan Channel), 1995

F–Flood, Dir. 032° True E–Ebb, Dir. 212° True

Month	Day	Slack (h m)	Maximum (h m)	Knots
April	1 Sa	0035	0345	3.1E
		0640	0940	3.0F
		1250	1555	2.8E
		1845	2150	3.2F
	2 Su	0105	0415	3.0E
		0715	1010	3.0F
		1325	1625	2.6E
		1915	2220	3.1F
	3 M	0130	0445	2.9E
		0745	1040	2.8F
		1355	1655	2.4E
		1945	2250	2.9F
	4 Tu	0200	0515	2.7E
		0820	1110	2.6F
		1425	1725	2.1E
		2015	2320	2.6F
	5 W	0225	0545	2.4E
		0850	1145	2.4F
		1455	1800	1.8E
		2050	2350	2.3F
	6 Th	0255	0615	2.1E
		0925	1220	2.1F
		1535	1835	1.4E
		2125		
	7 F		0030	2.0F
		0330	0655	1.8E
		1005	1305	1.8F
		1625	1920	1.1E
		2210		
	8 Sa ◐		0115	1.6F
		0420	0745	1.4E
		1100	1400	1.5F
		1730	2035	0.9E
		2320		
	9 Su		0215	1.3F
		0525	0905	1.2E
		1210	1515	1.4F
		1900	2210	0.9E
	10 M	0045	0340	1.2F
		0700	1035	1.3E
		1325	1640	1.5F
		2025	2330	1.3E
	11 Tu	0210	0510	1.4F
		0825	1145	1.6E
		1435	1750	1.9F
		2120		
	12 W		0025	1.8E
		0320	0620	1.8F
		0930	1245	2.0E
		1535	1845	2.4F
		2210		
	13 Th		0115	2.3E
		0410	0710	2.4F
		1020	1330	2.5E
		1620	1930	2.9F
		2250		
	14 F		0200	2.8E
		0455	0755	2.9F
		1105	1415	2.8E
		1705	2015	3.4F
		2330		
	15 Sa ○		0240	3.3E
		0540	0840	3.3F
		1150	1455	3.1E
		1750	2055	3.7F
	16 Su	0005	0320	3.6E
		0620	0920	3.6F
		1230	1535	3.3E
		1830	2135	3.8F
	17 M	0045	0400	3.7E
		0700	1000	3.7F
		1310	1615	3.3E
		1910	2215	3.8F
	18 Tu	0125	0440	3.6E
		0745	1040	3.6F
		1355	1700	3.1E
		1955	2255	3.6F
	19 W	0205	0520	3.4E
		0825	1125	3.4F
		1440	1745	2.8E
		2040	2340	3.2F
	20 Th	0250	0605	3.1E
		0915	1210	3.1F
		1530	1835	2.4E
		2130		
	21 F ◑		0030	2.8F
		0340	0700	2.6E
		1005	1305	2.6F
		1630	1935	2.0E
		2225		
	22 Sa		0125	2.3F
		0435	0800	2.2E
		1105	1405	2.3F
		1740	2045	1.7E
		2335		
	23 Su		0230	1.8F
		0550	0915	1.9E
		1215	1520	2.0F
		1905	2205	1.6E
	24 M	0055	0355	1.6F
		0715	1035	1.8E
		1325	1645	2.0F
		2020	2320	1.8E
	25 Tu	0215	0520	1.7F
		0835	1145	1.9E
		1435	1755	2.2F
		2125		
	26 W		0025	2.1E
		0320	0630	2.0F
		0940	1245	2.1E
		1535	1850	2.4F
		2210		
	27 Th		0115	2.4E
		0415	0720	2.3F
		1030	1330	2.3E
		1625	1935	2.6F
		2255		
	28 F		0200	2.6E
		0500	0805	2.5F
		1115	1415	2.5E
		1705	2015	2.8F
		2330		
	29 Sa ●		0240	2.8E
		0540	0840	2.7F
		1155	1455	2.5E
		1740	2050	2.9F
	30 Su	0000	0315	2.9E
		0615	0910	2.8F
		1225	1530	2.5E
		1815	2120	2.9F
May	1 M	0030	0345	2.8E
		0645	0945	2.8F
		1300	1600	2.4E
		1850	2150	2.8F
	2 Tu	0100	0415	2.7E
		0720	1015	2.7F
		1330	1630	2.2E
		1920	2220	2.7F
	3 W	0130	0445	2.6E
		0750	1045	2.8F
		1400	1705	2.0E
		1955	2255	2.5F
	4 Th	0200	0515	2.4E
		0825	1120	2.5F
		1435	1735	1.8E
		2030	2330	2.3F
	5 F	0235	0550	2.2E
		0900	1200	2.3F
		1515	1815	1.6E
		2110		
	6 Sa		0010	2.1F
		0310	0635	1.9E
		0945	1245	2.1F
		1605	1905	1.4E
		2200		
	7 Su ◐		0100	1.8F
		0400	0725	1.7E
		1035	1335	1.9F
		1705	2015	1.3E
		2305		
	8 M		0200	1.6F
		0505	0835	1.5E
		1135	1440	1.8F
		1815	2130	1.3E
	9 Tu	0020	0310	1.5F
		0625	0955	1.5E
		1245	1555	1.9F
		1930	2240	1.6E
	10 W	0135	0430	1.6F
		0745	1105	1.7E
		1355	1705	2.1F
		2035	2345	2.0E
	11 Th	0240	0540	2.0F
		0855	1205	2.0E
		1455	1805	2.5F
		2125		
	12 F		0040	2.4E
		0340	0640	2.4F
		0950	1300	2.4E
		1550	1900	2.9F
		2215		
	13 Sa		0125	2.9E
		0430	0730	2.9F
		1040	1345	2.7E
		1640	1945	3.2F
		2300		
	14 Su ○		0210	3.2E
		0515	0815	3.2F
		1130	1430	3.0E
		1725	2030	3.5F
		2340		
	15 M		0255	3.5E
		0600	0900	3.5F
		1215	1515	3.1E
		1810	2115	3.6F
	16 Tu	0025	0340	3.6E
		0645	0945	3.6F
		1300	1600	3.1E
		1855	2200	3.5F
	17 W	0105	0425	3.5E
		0725	1025	3.5F
		1345	1645	3.0E
		1940	2240	3.4F
	18 Th	0150	0510	3.3E
		0810	1110	3.4F
		1430	1735	2.8E
		2030	2325	3.1F
	19 F	0235	0555	3.0E
		0900	1200	3.1F
		1520	1825	2.5E
		2120		
	20 Sa		0015	2.7F
		0325	0645	2.6E
		0950	1250	2.8F
		1615	1925	2.2E
		2215		
	21 Su ◑		0110	2.3F
		0425	0745	2.3E
		1045	1345	2.4F
		1720	2025	1.9E
		2320		
	22 M		0210	1.9F
		0530	0850	1.9E
		1145	1450	2.1F
		1830	2135	1.8E
	23 Tu	0030	0325	1.7F
		0645	1000	1.7E
		1250	1600	2.0F
		1940	2245	1.8E
	24 W	0140	0440	1.6F
		0800	1105	1.7E
		1355	1710	2.0F
		2040	2345	1.9E
	25 Th	0245	0550	1.8F
		0910	1205	1.8E
		1455	1810	2.1F
		2135		
	26 F		0040	2.1E
		0340	0645	2.0F
		1005	1300	1.9E
		1545	1900	2.2F
		2220		
	27 Sa		0125	2.3E
		0430	0730	2.2F
		1050	1345	2.0E
		1630	1940	2.3F
		2255		
	28 Su		0210	2.4E
		0510	0810	2.3F
		1130	1425	2.0E
		1710	2020	2.4F
		2330		
	29 M ●		0245	2.5E
		0545	0845	2.5F
		1205	1505	2.1E
		1750	2050	2.5F
	30 Tu	0005	0320	2.5E
		0620	0920	2.5F
		1240	1540	2.1E
		1825	2125	2.5F
	31 W	0035	0350	2.6E
		0655	0955	2.6F
		1310	1615	2.1E
		1900	2200	2.5F
June	1 Th	0105	0425	2.5E
		0725	1025	2.7F
		1345	1645	2.1E
		1935	2235	2.5F
	2 F	0140	0500	2.5E
		0805	1105	2.7F
		1420	1725	2.0E
		2015	2315	2.4F
	3 Sa	0215	0535	2.3E
		0840	1140	2.6F
		1500	1805	2.0E
		2100	2355	2.3F
	4 Su	0300	0620	2.2E
		0925	1225	2.5F
		1545	1850	1.9E
		2150		
	5 M		0045	2.2F
		0350	0710	2.0E
		1010	1315	2.4F
		1635	1945	1.8E
		2245		
	6 Tu ◐		0140	2.0F
		0445	0805	1.9E
		1105	1410	2.3F
		1735	2050	1.8E
		2345		
	7 W		0240	1.9F
		0555	0910	1.8E
		1205	1515	2.2F
		1840	2155	1.9E
	8 Th	0055	0350	1.9F
		0705	1020	1.8E
		1310	1620	2.3F
		1945	2300	2.1E
	9 F	0200	0500	2.1F
		0820	1125	2.0E
		1415	1725	2.4F
		2045		
	10 Sa		0000	2.4E
		0305	0605	2.4F
		0925	1230	2.2E
		1515	1825	2.7F
		2140		
	11 Su		0100	2.7E
		0400	0705	2.7F
		1020	1325	2.5E
		1615	1920	2.9F
		2235		
	12 M		0150	3.0E
		0455	0755	3.0F
		1115	1415	2.7E
		1705	2010	3.1F
		2325		
	13 Tu ○		0240	3.3E
		0540	0845	3.3F
		1200	1505	2.9E
		1755	2100	3.3F
	14 W	0010	0325	3.4E
		0630	0930	3.5F
		1250	1550	3.0E
		1845	2145	3.3F
	15 Th	0055	0410	3.4E
		0715	1015	3.5F
		1335	1640	3.0E
		1935	2230	3.2F
	16 F	0140	0455	3.3E
		0800	1100	3.4F
		1420	1725	2.9E
		2020	2315	3.0F
	17 Sa	0225	0545	3.0E
		0845	1145	3.2F
		1510	1815	2.7E
		2110		
	18 Su		0005	2.8F
		0315	0630	2.7E
		0930	1230	3.0F
		1555	1905	2.4E
		2200		
	19 M ◑		0050	2.5F
		0405	0720	2.4E
		1015	1320	2.6F
		1650	2000	2.2E
		2250		
	20 Tu		0145	2.1F
		0500	0815	2.0E
		1105	1410	2.3F
		1745	2055	1.9E
		2350		
	21 W		0240	1.8F
		0605	0915	1.7E
		1200	1510	2.0F
		1845	2155	1.8E
	22 Th	0055	0350	1.6F
		0715	1020	1.4E
		1300	1610	1.8F
		1945	2300	1.7E
	23 F	0200	0500	1.5F
		0830	1125	1.4E
		1405	1715	1.7F
		2045		
	24 Sa		0000	1.7E
		0300	0605	1.6F
		0930	1225	1.4E
		1505	1815	1.7F
		2135		
	25 Su		0050	1.9E
		0355	0700	1.7F
		1025	1320	1.5E
		1600	1905	1.8F
		2225		
	26 M		0140	2.0E
		0440	0745	2.0F
		1110	1405	1.6E
		1645	1950	2.0F
		2305		
	27 Tu ●		0220	2.2E
		0520	0825	2.2F
		1150	1445	1.8E
		1730	2030	2.1F
		2340		
	28 W		0300	2.3E
		0555	0900	2.4F
		1220	1520	2.0E
		1810	2105	2.3F
	29 Th	0015	0335	2.5E
		0630	0935	2.6F
		1255	1600	2.2E
		1845	2145	2.5F
	30 F	0050	0410	2.6E
		0705	1010	2.8F
		1330	1635	2.3E
		1925	2220	2.6F

Time meridian 60° W. 0000 is midnight. 1200 is noon.

Table 1 of the Tidal Current Tables
Figure 12-11

TABLE 2 – CURRENT DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	Meter Depth	POSITION		TIME DIFFERENCES				SPEED RATIOS		AVERAGE SPEEDS AND DIRECTIONS							
			Latitude	Longitude	Min. before Flood	Flood	Min. before Ebb	Ebb	Flood	Ebb	Minimum before Flood		Maximum Flood		Minimum before Ebb		Maximum Ebb	
		ft	North	West	h m	h m	h m	h m			knots	Dir.	knots	Dir.	knots	Dir.	knots	Dir.
	BAY OF FUNDY Time meridian, 60° W				on Bay of Fundy Entrance, p.4													
1	Brazil Rock, 6 miles east of		43° 22'	65° 18'	−2 02	−2 00	−1 56	−2 00	0.4	0.4	0.0	– –	1.0	275°	0.0	– –	1.0	050°
6	Cape Sable, 3 miles south of		43° 20'	65° 38'	−3 02	−2 10	−1 21	−2 10	1.0	0.8	0.0	– –	2.2	275°	0.0	– –	2.0	095°
11	Cape Sable, 12 miles south of		43° 11'	65° 37'	−1 12	−1 00	−0 46	−1 00	0.7	0.7	0.0	– –	1.7	285°	0.0	– –	1.6	090°
16	Blonde Rock, 5 miles south of		43° 15'	65° 59'	−1 02	−0 50	−0 36	−0 50	0.9	0.8	0.0	– –	2.0	310°	0.0	– –	2.0	125°
21	Seal Island, 13 miles southwest of		43° 16'	66° 15'	−0 17	+0 10	+0 39	+0 10	1.1	0.7	0.0	– –	2.6	325°	0.0	– –	1.6	140°
26	Cape Fourchu, 17 miles southwest of		43° 34'	66° 24'	+0 38	+0 45	+0 44	+0 45	0.5	0.5	0.0	– –	1.2	355°	0.0	– –	1.2	145°
31	Cape Fourchu, 4 miles west of		43° 47'	66° 15'	−0 12	0 00	+0 09	0 00	0.9	0.7	0.0	– –	2.0	000°	0.0	– –	1.7	175°
36	Lurcher Shoal, 6 miles east of		43° 52'	66° 21'	+0 08	+0 30	+0 39	+0 30	0.9	0.8	0.0	– –	2.0	355°	0.0	– –	1.8	175°
41	Lurcher Shoal, 10 miles west of		43° 46'	66° 42'	+0 23	+0 30	−0 34	+0 30	0.6	0.7	0.0	– –	1.4	000°	0.0	– –	1.6	160°
46	Lurcher Shoal, 10 miles northwest of		43° 59'	66° 37'	−0 02	+0 30	+0 49	+0 30	0.8	0.5	0.0	– –	1.8	005°	0.0	– –	1.2	175°
51	Brier Island, 5 miles west of		44° 13'	66° 30'	+0 43	+0 50	+0 54	+0 50	1.2	1.0	0.0	– –	2.7	005°	0.0	– –	2.5	185°
56	Brier Island, 15 miles west of		44° 17'	66° 44'	−0 42	−0 15	+0 14	−0 15	0.6	0.5	0.0	– –	1.4	060°	0.0	– –	1.2	250°
61	Gannet Rock, 5 miles southeast of		44° 29'	66° 41'	+0 38	+0 30	+0 09	+0 30	1.1	1.6	0.0	– –	2.6	040°	0.0	– –	3.9	230°
66	Boars Head, 10 miles northwest of		44° 31'	66° 23'	+0 48	+0 55	+0 59	+0 55	0.8	0.8	0.0	– –	1.9	020°	0.0	– –	2.0	205°
71	Prim Point, 20 miles west of		44° 44'	66° 15'	+0 38	+0 45	+0 54	+0 45	0.7	0.6	0.0	– –	1.6	040°	0.0	– –	1.4	235°
76	Cape Spencer, 14 miles south of		44° 58'	65° 57'	+0 51	+0 55	+0 57	+0 55	0.7	0.7	0.0	– –	1.7	050°	0.0	– –	1.6	245°
81	BAY OF FUNDY ENTRANCE		44° 45.2'	66° 55.9'	*Daily predictions*						0.0	– –	2.3	032°	0.0	– –	2.4	212°
	MAINE COAST Time meridian, 75° W																	
86	Eastport, Friar Roads		44° 54'	66° 59'	0 00	0 00	0 00	0 00	1.2	1.2	0.0	– –	3.0	210°	0.0	– –	3.0	040°
91	Western Passage, off Kendall Head		44° 55.9'	67° 00.0'	+0 27	+0 11	+0 13	+0 40	1.4	1.3	0.0	– –	3.2	319°	0.0	– –	3.1	142°
96	Western Passage, off Frost Ledge		44° 57.9'	67° 01.9'	+0 33	+0 04	−0 16	+0 15	0.9	0.7	0.0	– –	2.1	330°	0.0	– –	1.7	150°
101	Pond Point, 7.6 miles SSE of		44° 20.1'	67° 30.2'	+0 13	−0 20	−1 33	−0 05	0.2	0.5	0.0	– –	0.5	015°	0.0	– –	1.2	215°
106	Moosabec Reach, east end		44° 31.71'	67° 34.36'	−2 45	−3 08	−3 13	−3 39	0.4	0.4	0.0	– –	1.0	110°	0.0	– –	1.0	258°
111	Moosabec Reach, west end		44° 31.25'	67° 39.00'	−1 43	−1 43	−2 00	−1 44	0.4	0.5	0.0	– –	1.0	092°	0.0	– –	1.2	253°
116	Bar Harbor, 1.2 miles east of <1>		44° 23.0'	68° 10.0'	– – –	+0 30	– – –	+0 48	0.1	0.3	0.0	– –	0.2	328°	0.0	– –	0.7	148°
121	Casco Passage, east end, Blue Hill Bay		44° 11.7'	68° 27.9'	−1 49	−1 44	−1 02	−1 58	0.3	0.3	0.0	– –	0.7	086°	0.0	– –	0.7	284°
126	Hat Island, SE of, Jericho Bay		44° 08.0'	68° 29.7'	−1 02	−0 35	−0 50	−1 20	0.4	0.5	0.0	– –	0.9	318°	0.0	– –	1.3	124°
131	Clam I., NW of, Deer I. Thorofare	14	44° 09.87'	68° 36.23'	−2 14	−0 15	−0 57	−2 46	0.1	0.1	0.0	– –	0.2	004°	0.0	– –	0.2	199°
136	Grog Island, E of, Deer Island Thorofare	14	44° 09.72'	68° 37.23'	−2 16	−2 22	−2 27	−3 31	0.1	0.1	0.0	– –	0.2	020°	0.1	302°	0.3	235°
141	Russ Island, N of, Deer Island Thorofare	14	44° 09.18'	68° 38.78'	−2 12	−2 10	−2 29	−3 16	0.2	0.2	0.0	– –	0.4	074°	0.0	– –	0.6	265°
146	Crotch Island–Moose Island, between <58>	14	44° 08.85'	68° 40.58'	Currents are unidirectional													
151	Isle au Haut, 0.8 mile E of Rich's Pt	11	44° 05'	68° 35'	−0 53	−1 07	−1 07	−1 19	0.6	0.6	0.0	– –	1.4	336°	0.0	– –	1.5	139°
	East Penobscot Bay																	
156	Mark Island, north of	14	44° 08.20'	68° 42.17'	−0 18	−1 01	−2 27	−0 22	0.1	0.2	0.0	– –	0.3	013°	0.1	300°	0.4	164°
161	Widow Island–Stimpson Island, between	14	44° 07.95'	68° 49.50'	−0 43	−0 49	+0 04	−1 08	0.3	0.2	0.0	– –	0.6	302°	0.0	– –	0.5	118°
166	Eagle Island, 0.4 nautical mile S of	14	44° 11.63'	68° 46.93'	−0 18	−0 55	−2 20	−1 46	0.4	0.4	0.2	030°	0.9	336°	0.3	050°	1.0	147°
171	Burnt Island–Oak Island, between	14	44° 11.47'	68° 49.13'	−0 18	−1 19	−2 22	−0 57	0.3	0.5	0.1	347°	0.7	290°	0.0	– –	1.3	098°
176	Butter I., 0.3 nautical mile SE of	14	44° 13.33'	68° 46.67'	−2 43	−2 14	−0 25	−1 36	0.1	0.3	0.0	– –	0.3	050°	0.1	150°	0.6	194°
						−1 31			0.1				0.2	032°				
						−0 23			0.2				0.4	077°				
181	Bradbury Island, ESE of	14	44° 14.03'	68° 44.07'	+0 11	−0 17	−0 53	−0 56	0.2	0.3	0.2	305°	0.5	025°	0.1	304°	0.7	225°
186	Compass Island, 0.4 nmi. ENE of	14	44° 13.00'	68° 51.33'	−1 44	−1 22	−1 25	−1 01	0.1	0.1	0.2	092°	0.3	015°	0.0	– –	0.3	175°
191	Scrag Island, 0.3 nautical mile SW of	14	44° 13.33'	68° 50.62'	−0 45	−0 27	−0 55	−0 55	0.2	0.1	0.0	– –	0.4	010°	0.1	078°	0.3	197°
196	Great Spruce Head Island, west of	14	44° 14.30'	68° 50.18'	−1 14	−0 54	−0 26	−1 19	0.2	0.1	0.0	– –	0.3	003°	0.0	– –	0.3	174°
201	Horse Head Island, 0.2 nmi. ENE of	14	44° 15.07'	68° 50.67'	See Rotary tidal currents, table 2.													
206	Pickering Island, south of	14	44° 15.63'	68° 45.38'	−2 45	−1 37	−1 56	−2 37	0.2	0.2	0.2	203°	0.6	300°	0.3	201°	0.6	150°
211	Little Eaton Island, NNE of	14	44° 16.45'	68° 43.87'	−0 43	+0 12	+0 02	−0 19	0.2	0.1	0.0	– –	0.4	300°	0.2	224°	0.3	106°
216	Pickering Island, north of	14	44° 16.48'	68° 45.28'	See Rotary tidal currents, table 2.													
221	Hog Island, ESE of	14	44° 16.52'	68° 46.87'	−0 13	−0 02	−0 33	−0 51	0.1	0.2	0.0	– –	0.3	024°	0.2	105°	0.5	180°
226	Little Deer I.–Sheep I., between	14	44° 16.78'	68° 43.43'	−0 13	−0 37	+0 33	−0 52	0.2	0.2	0.1	231°	0.6	310°	0.0	– –	0.6	124°
231	Swains Ledge, WSW of	14	44° 16.97'	68° 45.28'	See Rotary tidal currents, table 2.													
236	Swains Ledge, 0.3 nautical mile SW of	14	44° 17.13'	68° 43.87'	−0 46	−0 22	−0 55	−1 07	0.2	0.2	0.0	– –	0.5	358°	0.0	– –	0.4	170°
241	Pond Island–Western Island, between	14	44° 17.58'	68° 49.00'	−1 44	−1 13	−1 56	−1 34	0.2	0.2	0.0	– –	0.4	356°	0.0	– –	0.6	172°

Endnotes can be found at the end of table 2.

Table 2 of the Tidal Current Tables
Figure 12-12

B.18.c. Time and speed	Select the station closest to your area of concern. (Sometimes it may be a reference station which means no calculating is needed). If using a subordinate station, apply its time differences to the time of slack and maximum current at the reference station to obtain the corresponding times at the subordinate station. Calculate the maximum speed at the subordinate station, by multiplying the maximum speed at the reference station by the appropriate flood or ebb ratio.
B.18.d. Current velocity	Flood direction is the approximate true direction toward which the flooding current flows. Ebb direction is generally close to the reciprocal of the flood direction. Average flood and ebb speeds are averages of all the flood and ebb currents. Use Table 3 to find the velocity of the current at a specific time.
B.18.e. Actual vs. predicted conditions	NOS also publishes the *Tide Tables* for determining height and times of the tides. Their procedures are similar to those for tidal current calculations. In using both the *Tide Tables* and the *Tidal Current Tables*, actual conditions frequently vary considerably from predicted conditions in the tables. Changes in wind force and direction, or variations in atmospheric pressure, produce variations in the ocean water level, especially the high-water height. The actual heights of both high-water and low-water levels are higher than the predicted heights with an on-shore wind or a low barometer. With a high barometer or off-shore wind, those heights usually are lower than predicted. When working with the <u>Current Tables</u>, the actual times of slack or maximum current sometimes differ from the predicted times by as much as half an hour. Occasionally, the difference may be as much as an hour. However, a comparison between predicted and observed times of slack shows that.. more than 90% of slack water predictions are accurate to within half an hour. To get the full advantage of a favorable current or slack water, the navigator should plan to reach an entrance or strait at least half an hour before the predicted time of the desired condition of the current.